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ANALYSES OF DRL BEHAVIOR IN YOUNG CHILDREN[1,2]

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Summary.—In young children, DRL 10 sec. and DRL 18 sec. schedules of snack reinforcement generated and maintained low levels of responding which, when compared to the animal and human DRL literature revealed efficient temporal responding. This low behavioral baseline was not impaired by extinction operations or by the introduction of a second response manipulandum intended to measure collateral behavior.

Experimental demonstrations of reinforcement schedule control over the behavior of children younger than 2 yr. of age are noticeably scarce in the child-operant literature (Bijou & Baer, 1966). When control procedures have been implemented with children of these ages (Rheingold, Stanley & Doyle, 1964; Weisberg & Fink, 1966; Weisberg, 1966), it is always in the direction of building relatively high and sustained response rates with an eye toward those factors contributing to deviations or a lowering of this rate. The alternative approach, that of conditioning a response to occur at a steady but infrequent rate by a schedule of reinforcement known as the differential reinforcement of low rates (DRL), also has much to offer for a developmental analysis of behavior (Stoddard, 1962).

In a DRL schedule, a timer, which is preset to some value, programs a potential reinforcement immediately upon "timing out" and the first response occurring anytime afterward is reinforced. This reinforced response resets the timer as do all other nonreinforced responses made before the time-out interval. This paper purports to demonstrate primarily, that low behavioral baselines can be produced in young children, commonly reputed to be "impulsive," and that the resultant performances are as efficient and as reproducible as those reported with other organisms. Secondary considerations concern the effects of DRL extinction and to what extent these children will respond on an independent collateral manipulandum as a means of mediating time.

METHOD

Subjects and Setting

Five children, ranging in age from 15 to 41 mo., participated. These *S*s were in temporary residence at a local shelter home and it was in a room at this home that the experiment was conducted. During actual testing, *S* sat strapped

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into a highchair before a large wooden frame which housed a Universal Feeder. A lever, easily within reach of *S*, was mounted to the right side of the feeder support. In the same room as *S* was an observer (*O*) who sat obscured from *S*'s view behind an equipment cart which was located about 6 ft. from the back of the feeder. The cart contained noiseless program circuitry, power supplies, and a cumulative recorder. The lever, when pressed, produced an audible click made by the stepping motor of the cumulative recorder. Throughout testing sessions, social and verbal interaction between *S* and *O* was kept to a minimum.

Magazine Training

By means of shaping procedure (Weisberg & Fink, 1966) *S* was encouraged to sit before the feeder and eat a variety of snack reinforcers (small pieces of cinnamon crisp crackers, raisins, marshmallows, and chocolate chip candies) as they were individually and automatically dispensed into a food tray. At first, *O* was seated next to *S*, but once *S* repeatedly looked in the vicinity of the food tray whenever the feeder motor signalled an upcoming reinforcer, the distance between *O* and *S* slowly increased. By the end of training, *O* could dispense snacks behind the equipment cart without *S*'s becoming upset at being left alone. This procedure took from 10 to 15 min. within which time 30 to 35 snacks were dispensed.

Training

The lever, previously removed during magazine training, was available and when pressed, delivered reinforcements according to a DRL 2 sec. schedule. (The DRL 2 prevented hoarding behavior and post-reinforcement responding, two conditions likely to occur with a crf schedule.) For 1 *S* who failed to lever press after the first 5 min. of the first session, *O* passively placed *S*'s hand on the lever until three reinforcements were delivered on a DRL 2 basis; thereafter, lever pressing was "self-initiated." All other *S*s learned to lever press without verbal instruction or demonstration.

After two sessions of DRL 2 training, all *S*s received a number of DRL 10 sec. sessions followed by, in the case of 3 *S*s, several DRL 18 sec. sessions. During each DRL and DRL 10 session, 50 reinforcements were given but this number was reduced to 30 during the DRL 18 sessions in order to equalize session length. Changes in schedule conditions, e.g., from DRL 10 to DRL 18, were always introduced without forewarning or explanation as were the programming of brief extinction probes during one or two DRL 10 sessions and the installment of a collateral panel during several DRL 18 sessions.

*S*s were tested 6 days a week and had not eaten for 2½ to 3 hr. prior to an experimental session.

Results and Discussion

In contrast to high and sustained response rates obtained with toddlers working on FR, VI and VR schedules of food reinforcement (Weisberg & Fink,

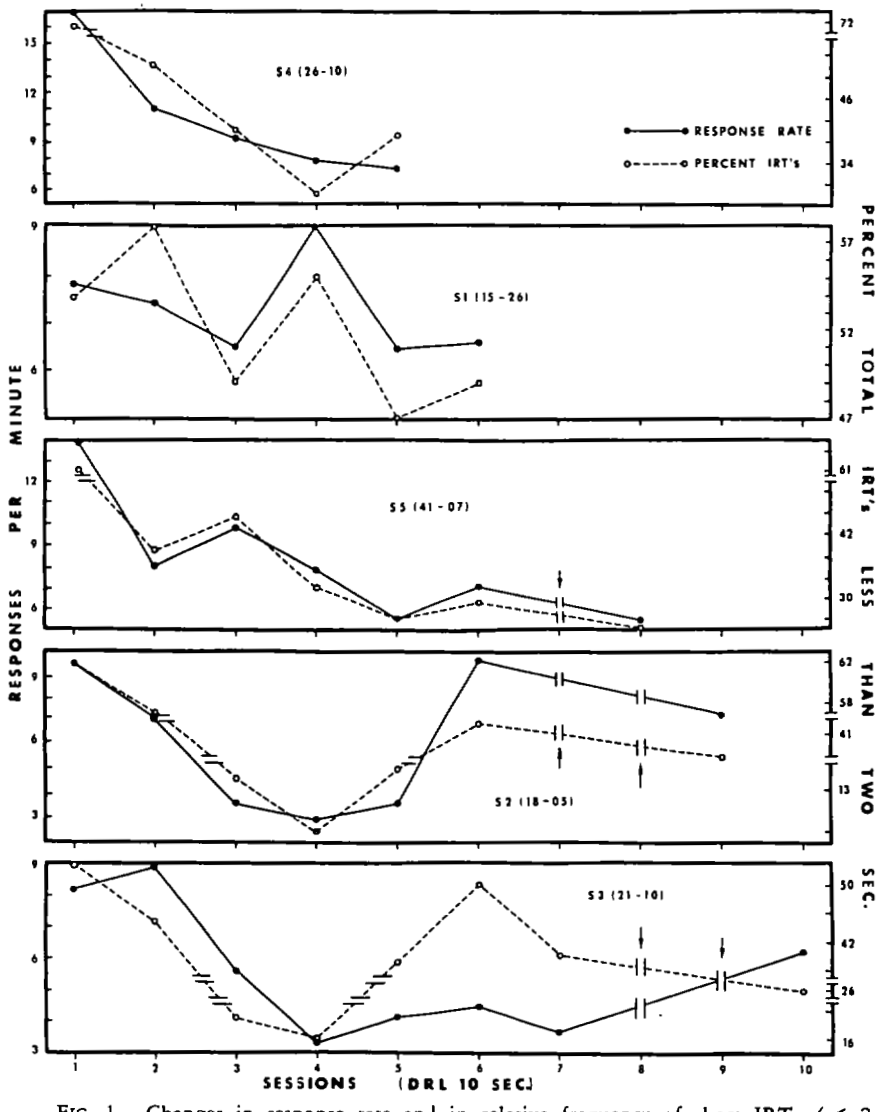

FIG. 1. Changes in response rate and in relative frequency of short IRTs (< 2 sec.). Arrows indicate sessions during an extinction test probe. Age of each *S* (month-day) is given in parentheses.

1966; Weisberg, 1966), Fig. 1 shows that the DRL 10 sec. schedule generated much lower rates (6 to 17 responses per min.) in these same-aged *S*s. With continued training, DRL 10 rates fell, albeit nonsystematically, for most *S*s and correlated with this response attenuation was a drop in the relative frequency of responses having inter-response times (IRTs) of less than 2 sec. Simultaneous with the reduction in the proportion of IRTs shorter than the reinforced interval was a progressive build-up of IRTs in the middle (10 to 14 sec.) and at the end ($>$ 24 sec.) of the IRT distribution.[4]

Two other indices were computed for each session: the number of reinforcements per response and the observed reinforcement rate (reinf./min.) relative to the optimal reinforcement rate (6 under a DRL 10). Both ratios yielded values which were within the limits reported in the animal and human DRL literature (Stoddard, 1962; Staddon, 1965). In terms of the first measure, after the first two sessions approximately 40% of all responses emitted by a given *S* resulted in a reinforcement; *S*2 and *S*3 were most efficient, with these ratios often reaching values greater than 50%. For the second measure, subject breakdown averaged over the last two sessions was: .34 (*S*1); .40 (*S*2); .42 (*S*3); .34 (*S*4); and .45 (*S*5).

Cumulative records of *S*1's and *S*4's last DRL 10 sessions (Fig. 2, top two records) reveal several instances of spaced responding without intervening response "bursts." When bursts occasionally appear, they come at times following a reinforcement or as the DRL interval is approached (Sidman, 1956). The

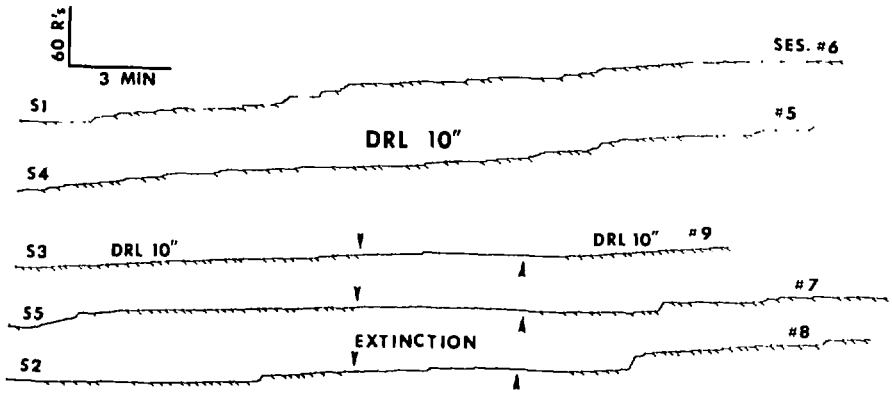

FIG. 2. DRL 10 sec. conditioning and extinction performance. Arrows border 5 min. of extinction.

[4]Tables presenting the relative frequency of IRTs and response probabilities (IRT/op.) as a function of 1.9-sec. class intervals for each session have been deposited with the American Documentation Institute, Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington, D. C. 20540. Request Document No. 9766, remitting $1.25 for 35-mm. microfilm or photocopies.

patterns of DRL 10 responding of the other 3 *S*s (Fig. 2, bottom three records) before and after 5 min. of extinction, also display fairly good and uniform temporal responding. Extinction operations did not disrupt DRL 10 conditioning performance by way of increasing response rate or by producing a petulant child, which indicates that DRL extinction behavior is more a function of prior schedule control than it is a result of a general frustrative or activation effect caused by reinforcer removal *per se*.

If anything, these extinction test probes as well as probes from other sessions suggest that extinction serves to lengthen periods of nonresponding (Kelleher, *et al.*, 1959). This finding, if further replicated with more *S*s and with a greater number of extinction probes, would be consistent with the view that during DRL conditioning the occurrence of nonreinforced lever presses becomes discriminative for not responding. Logically then, when all reinforcements are actually removed, even for those responses longer than the DRL interval, responding should initially become less frequent and the proportion of long IRTs should increase. An important stipulation for this prediction of course, is that *S*s do not have a prior history whereby a nonreinforced response comes to signal further responding, i.e., no experience with ratio schedules.

When the DRL interval was raised to 18 sec. for three *S*s (*S*1 and *S*4 were adopted), the previous DRL 10 response rate was reduced still further and, as Fig.

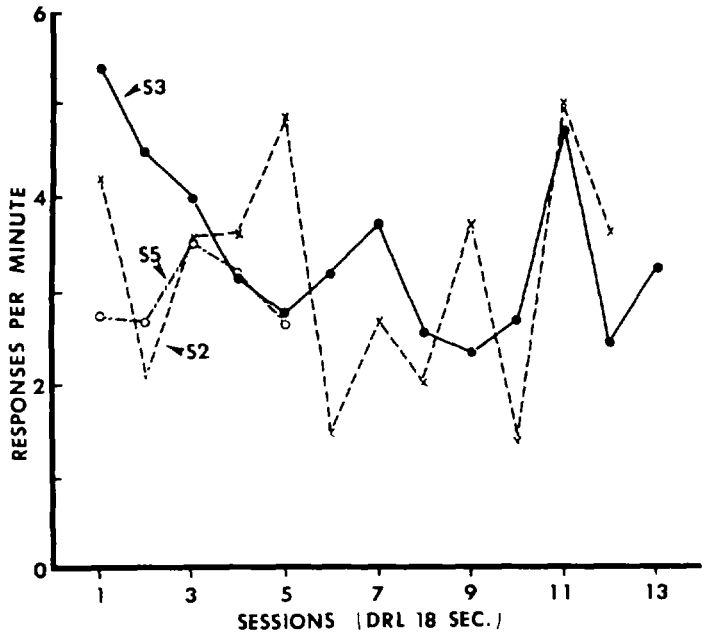

FIG. 3. Changes in response rate during DRL 18 sec. training

3 demonstrates, this low level was maintained for most of the sessions. Not shown are the changes in the percentage of short IRTs (< 3 sec.) which again covaried with response rate. Other measures computed for each session, the number of reinforcements per response and the ratio of the observed to the optimal reinforcement rate, also indicated fairly efficient DRL 18 behavior; for each *S*, values of .40 or greater were obtained for each index in the majority of sessions.

To record potential mediating behavior, a response panel was mounted to the left side of the feeder support during the latter part of the DRL 18 training for *S*2 and *S*3. Responding on this panel bore no relationship to responding on the DRL lever but it was hoped that *S*s would use the panel to mediate time and perhaps engage in superstitious responding. Fig. 4 shows the pattern of responding on the DRL lever and on the collateral panel. For both *S*s, responding on the panel, which had been greatest during the session it was introduced, dissipated with time and was clearly not incorporated as part of *S*s' mediating behavior. Note however, that the efficient DRL 18 performance on the lever was not impaired during these sessions.

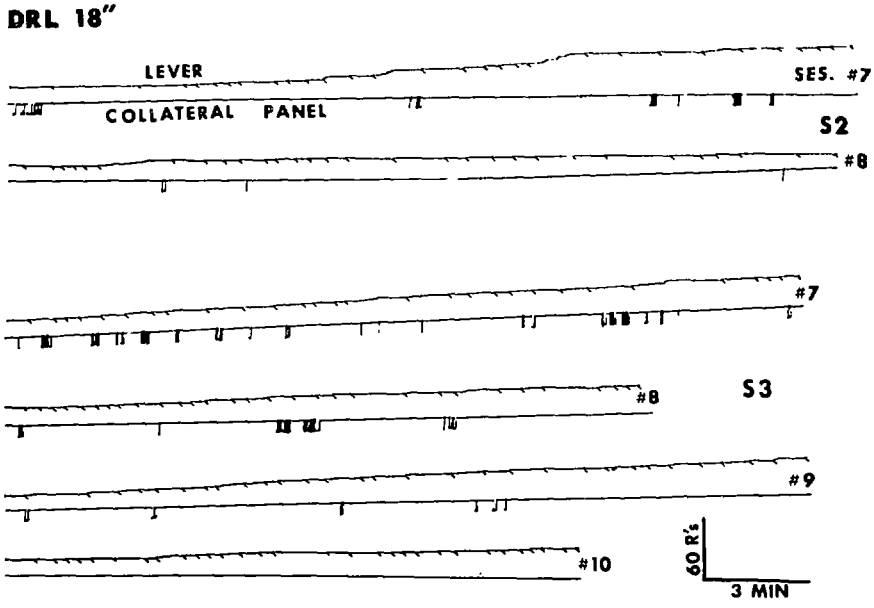

FIG. 4. Collateral behavior by *S*2 and *S*3 while on a DRL 18 sec. schedule. In each pair of records, the top one is DRL 18 sec. lever-pressing performance and the bottom one, responding on a collateral panel.

Exactly why *S*2 and *S*3 ceased responding on the panel cannot be determined for there are several places in Fig. 4 where panel pressing immediately preceded a reinforced lever press. It may be that these *S*s had already adopted good self-

mediating behaviors prior to the panel's installment and that had it been introduced earlier in the training regime, the panel would have acquired greater utility as a mediating device. At any rate, the fact that responding to the panel was initially high (novelty?) argues against a notion that the activity levels for all behaviors are marginal and thus these *S*s were more susceptible to control by a DRL schedule. As has already been mentioned, control of behavior with schedules which build high rates has been documented in young children having similar backgrounds to those reported here (Weisberg, 1966).

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